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East Europe Report

SCIENTIFIC AFFAIRS

(FOUO 4/82)

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INTERNATIONAL AFFAIRS

JOINT CSSR-USSR AERIAL RECONNAISSANCE EXPERIMENT DESCRIBED

Prague GEODETICKY A KARTOGRAFICKY OBZOR in Czech No 4, 1982 pp 96-97

[Article by Engr Jiri Sima, CSc, Center for Remote Terrain Sensing, Institute of Geodesy, National Enterprise, Prague: "First Joint Czechoslovak-Soviet Experiment With the AN-30 Flying Laboratory"]

[Text] The first joint experiment, under the Czechoslovak-Soviet intergovernmental agreement on cooperation in remote terrain sensing, was held on 9-29 March 1982, on the territory of the CSSR. At the invitation of the Czech Geodetic and Cartographic Office (Cesky urad geodeticky a kartograficky), to which the CSSR government's resolution No 249 of 1977 had assigned the task cf coordinating the gathering and practical application of data from remote terrain sensing for the needs of the Czechoslovak economy, the USSR State Committee for Hydrometeorology and Control of the Living Environment sent to Czechoslovakia its AN-30 flying laboratory with a team of five scientists and specialists, so that aerial multispectral and thermal photographs could be taken of areas important from the viewpoint of the further development of our agriculture, forestry, management of water resources, geology and cartography.

The AN-30 flying laboratory was equipped with an MKF-6 M Zeiss Jena multispectral aerial camera, a set of three AFA aerial cameras that have frame constants of 50, 100 and 200 mm, and a Hasselblad 500 EL hand-held aerial camera of the Center for Remote Terrain Sensing (Stredisko dalkoveho pruzmumu Zeme), and with a Vulkan two-channel scannig infrared radiometer. The new Soviet thermovision (Vulkan) system, which records on film strip the thermal image of the earth's surface or of the surface of a body of water, in the range of reflected and natural radiation, was used specifically on this project for the first time on such a large scale and outside the Soviet Union. The AN-30 airplane has modern navigation aids that enable the navigator to keep the two-engine turbojet, flying at speeds of 400 to 500 km/h and at altitudes up to 7000 m, on the planned course within an error of 50 m.

The ground control surveys were made by two teams of scientists and technicians, namely: on the East Slovakia plain, by staff members of the MPVz SSR [SSR Ministry of Agriculture and Food] and MVLH SSR [SSR Ministry of Forestry and Water Resources], under the methodological guidance of the Slovak Academy of Sciences Institute of Geography (Geograficky ustav SAV); and on the Intercosmos program's Stritez test range in Trebic Okres, by staff members of the Center for Remote Terrain Sensing and of the Czechoslovak Academy of Sciences Institute of Geography (Geograficky ustav CSAV) in Brno.

Fig. 1

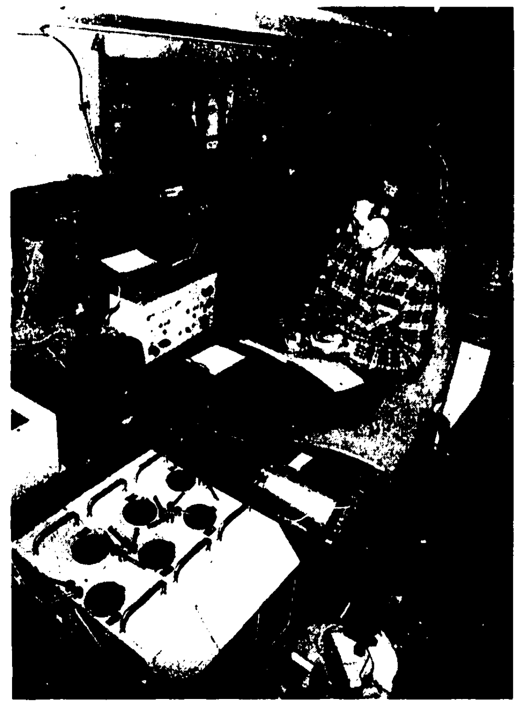

Fig. 2

The primary purpose of the experiment's scientific program was to explore the earth's natural resources. The season of the year, the use of infrared photography and the recording of the thermal image make it possible to determine the acreage of farmland that is waterlogged, and to what extent. Research in this direction concentrated on the East Slovakia plain and covered an area exceeding 150,000 hectares. The entire area was sensed twice by different procedures, so that multispectral photographs on a 1:50,000 scale, black-and-white infrared photographs on a 1:150,000 scale, color infrared photographs on a 1:100,000 scale, and a thermal scan in the 3-5 μm and 8-13 μm parts of the spectrum were obtained. The selected areas where control measurements were made on the ground were sensed four times by similar methods, but on larger scales (1:65,000 to 1:25,000).

In the basin of the Udava River (Humenne Okres) repeated photographing and thermal sensing were conducted to obtain data for a model of runoff after the melting of the snow cover, and to determine more accurately the supply of water in the snow cover. Solution of this task is one of the topics of the bilateral scientific and technical cooperation with the Soviet Union in the area of remote terrain sensing. For the geological and geomorphological investigation of the volcanic mountain ranges in Central and Eastern Slovakia, multispectral photographs were taken on a 1:50,000 scale, and an aerial photogrammetric survey on a 1:30,000 and 1:100,000 scale was made of the Vihorlat range, of the area between the two branches of the

Bodrog River, and of the Stavnica range. For the classification of timber stands in the Kremnica Mountains region, for the purpose of forestry research, and of college instruction of the interpretation of DPZ [dalkovy pruzkum Zeme; remote terrain sensing], inaccessible mixed timber stands were photographed from the air in black and white on a 1:9,000 scale against a background of snow cover, and in infrared on a 1:22,000 scale with the Hasselblad camera.

The experiment's scientific program investigated also questions of protecting the living environment. To determine the extent of damage caused by man to the environment in much-frequented recreational areas or in areas with a high density of vacation cottages, multispectral and color infrared photogrammetric surveys were made of the vicinity of the Zemplinska Sirava reservoir, and of the Kninice dam near Brno. These survey provide objective and meaningful data for territorial planning.

The parameters of the aerial surveys were always selected so that the photographs could be used in geodesy and cartography, geology, forestry and the management of water resources, to correct and update the basic and topical maps on scales of 1:10,000 to 1:200,000.

The results of the experiment with the AN-30 flying laboratory will be used also to solve certain tasks of basic and applied research. For this purpose, with the cooperation of the Center for Remote Terrain Sensing and the Czechoslovak Academy of Sciences Institute of Geography in Brno, a coordinated program was held on 16 March 1982 at the Intercosmos program's test range in Trebic Okres, in the course of which multispectral photographs were made with the MKF-6 camera aboard the AN-30 flying laboratory, from altitudes of 6200 and 3100 meters, while simultaneously photographs of the same spectral parameters were taken with the multispectral camera of the Czechoslovak Academy of Sciences Institute of Geography, from an altitude of 500 meters, aboard an AN-2 airplane of the Slovair Enterprise. At the same time, the spectral reflectance of various objects, and the temperature and moisture content of the soil and of the air were measured from the ground.

During the six flying days when the weather was favorable, eight flights were made from the airports in Bratislava and Kosice. The AN-30 flying laboratory logged a total of 26 hours and 50 minutes in the air. In all, the laboratory received for processing over 9000 frames of black-and-white zonal (multispectral) shots, black-and-white and color infrared survey shots, infrared photographs taken with the Hasselblad camera, and photographic recordings of thermal sensing covering an area of 209,000 hectares.

A press conference was held at the close of the experiment. It was attended by 31 journalists, and by party and government officials of the Slovak Socialist Republic. The press conference included an exhibit of some of the results of the surveys in East Slovakia, and an inspection of the AN-30 flying laboratory. While the airplane was at the Bratislava airport, excursions were organized for the managers and scientific staff members of the interested organizations. More than 100 persons participated in these excursions.

The first joint Czechoslovak-Soviet experiment with the AN-30 flying laboratory ended successful, without any unforeseen events and organizational complications, thanks to the detailed preparations and the maximum effort exerted by all the participating organs and organizations. The obtained remote terrain sensing data will be distributed to the interested organizations in May and June 1982, and the first data to be processed will be the ones obtained in East Slovakia. A preliminary assessment of the feasibility of their practical application, namely by organizations of the Ministry of Agriculture and Food, and of the Ministry of Forestry and Water Resources, is expected in September of this year. An evaluation of the experiment's scientific contribution, from the viewpoint of the objectives of the bilateral Czechoslovak-Soviet scientific and technical cooperation in remote terrain sensing, will be made before the end of 1982. Full and comprehensive practical application of the obtained data, by all interested organizations, will take about two years.

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CZECHOSLOVAKIA

CURRENT, FUTURE CHEMICAL FIBER PRODUCTION SURVEYED

Prague CHEMICKY PRUMYSL in Czech No 2, 1982 pp 105-111

[Article by Milan Drazdil, State Planning Commission, Prague: "Current Status and Prospects for Development of Chemical Fibers Abroad and in Czechoslovakia"]

[Text] This article briefly summarizes foreign and domestic developments in the production of chemical fibers. In the second part, tendencies and problems connected with the prospects for further development in this field, particularly in relation to the raw materials, investment and other capabilities, are traced, and forecasts for Czechoslovakia are presented.

Introduction

Chemical fibers, along with plastics, are the most rapidly developing products of the modern chemical industry since the Second World War. Thanks to the rapid growth in output of these products, they have gradually attained a dominant position, alongside cotton, among starting materials for the textile industry and other industries, as well as producing important structural changes. Their rapid growth was supported by several factors, especially the need to limit land area used for the production of natural fibers and to use it instead for growing food, progress in fibers research and development (discovery of new fiber-forming polymers, steady improvement of production technology, expanded selection and range of applications, modernization of the textile industry), the unprecedented growth of the petro-chemical base, increasing population, changes in styles of life and work, increased expenditures on attractive clothing, domestic furnishings and engineering materials. In terms of the starting materials used, there are fibers based on natural products, such as cellulose, glass and metals, and synthetic products, which are based on high-molecular-weight fiber-forming polymers. The purpose of this article is to evaluate briefly the development of the production of chemical fibers, i.e. cellulosics and synthetics, abroad and in Czechoslovakia, and to indicate several directions of their future development.

Development of Chemical Fiber Production Through 1980

In contrast to the majority of other industries, the chemical industry did not originate in an artisan trade, but resulted from consistent transfer of scientific research results into industrial practice. In addition, from the beginning, the development of the chemical industry was based on systematic objectives and relied less on trial and error than other industries had. As soon as the theoretical basis was sufficiently well known and well developed, the industry developed rapidly, often progressing by jumps.

This tendency was particularly apparent in the development of chemical fibers, and especially synthetics. So long as man lacked an adequate conception of the composition and structure of the material which surrounded him, it was obviously impossible for him to plan and systematically carry out the conversion of materials. As a result he was unable to provide the necessary manmade fibers for his clothing, the second basic necessity of life, and for thousands of years he had to turn to plant and animal products, i.e. fibers and biopolymers. It was only after he increased his knowledge of the nature of the chemical elements, the structure of chemical compounds and the laws governing chemical processes in the 18th and 19th centuries that various ways of modifying natural fibers and creating chemical ones, particularly fibers based on cellulose, were found. Thus from the point of view of basic textile raw materials, the year 1886 marks a milestone, for in that year the first chemical fiber was produced from nitrocellulose on the basis of a patent by H. de Chardonnet. Further important discoveries in the field of chemical fibers were not long in coming. The most effective of these on an industrial scale was the adoption of the viscose method in 1892 (invented by Cross, Bevan and Beadle), which was successfully used to produce viscose staple. But it was only in the 1920's that the pioneering work of Prof H. Staudinger, a Nobel Prize winner, resulted in a thorough knowledge of the macromolecular structure of cellulose. In the 1930's and early 1940's this work led to the discovery of the polymers which, with the exception of polypropylene, are the most important for synthetic fibers today, namely 6,6-polyamide, 6-polyamide, polyethylene terephthalate, and polyacrylonitrile. Although the main patents for the production of certain synthetic fibers date from much earlier (1913 for PVC [polyvinyl chloride] fiber and 1931 for PVA [polyvinyl alcohol] fiber), it was 6,6-PAD [polyamide] discovered by Carrothers, which in 1939 was successfully brought out on an industrial scale by the U.S. du Pont company, producer of the first thousand tons of nylon (the trade name came from the words "New York, LONdon").

The promising emergence of synthetic fibers was temporarily halted by the war, but research work never ceased, and in 1940 the Englishmen J. R. Whinfield and T. J. Dickson were awarded the basic patent for the production of polyester fiber, while in 1942 J. Zettner and M. Genes were able to patent the production of polyacrilonitrile fiber. After a brief interlude necessary for the reconstruction of industry destroyed by the war, nothing could prevent the production of chemical fibers from expanding rapidly.

In 1950 the highest prewar level in the production of viscose and acetate fibers was exceeded, and in the late 1950's and particularly the 1960's the production of synthetic fibers began to increase rapidly. Their unprecedented growth is graphically illustrated by the fact that between 1960 and 1970 the output of these products increased 7 times, while between 1960 and 1980 it increased 15 times. Table 1 describes the trend of chemical fiber production in the 20th century.

Table 1. World Output of Chemical Fibers (thousands of tons)

	1900	1920	1940	1950	1960	1970	1980
All chemical fibers	1	15	1,132	1,681	3,303	8,131	14,221
cellulose fibers	1	15	1,127	1,612	2,600	3,431	3,630
synthetics	-	-	5	69	703	4,700	10,591

Source: TEXTILE ORGANON, Enka AG

The table makes it clear that the production of cellulose fibers increased rapidly, particularly in the 1950's, then began to level off in the 1960's, while in the 1970's output began to fluctuate by ±200,000-400,000 tons a year. The maximum was achieved in 1973, when 3.661 million tons of cellulose fiber was produced worldwide. The rapid development of synthetics began in the second half of the 1950's as a result of the rapid increase in production of polyamide, polyester (PES) and polyacrylonitrile (PAN) fibers. The maximum annual growth worldwide occurred in 1969, 1971-1973, and 1979. Trends in the output of cellulose fibers are shown in Table 2.

Table 2. Worldwide Output of Main Types of Cellulose Fibers (thousand tons)

	1900	1920	1940	1950	1960	1970	1980
All cellulose fibers	1	15	1,127	1,612	2,600	3,431	3,630
textile and cord filament*	1	15	542	874	1,131	1,391	1,200
viscose staple and cable	-	-	585	738	1,469	2,040	2,430

*Including acetate and triacetate filament

Source: TEXTILE ORGANON, Enka AG

It is evident from Table 2 that initially the producers concentrated their full attention on continuous filament, which could be used to replace natural silk, since the very low silk production capabilities could not keep up with demand. The production of viscose staple was begun only in the late 1920's, but it expanded very rapidly, particularly in the late 1930's, when the tense international situation caused a sizeable drop in imports of strategic materials such as wool and cotton on world markets, with the result that in 1940 the output of viscose staple had already surpassed that of textile filament. During the war the output of cellulose fibers dropped by nearly 50 percent, but rapid restoration of capacities disrupted by the war revivified the industry, so that by 1950 the 1940 maximum had already been considerably exceeded. In the period between 1950 and 1970 production continued to increase, while producer interest began to turn more and more to viscose staple, which is suited to a number of remarkable applications in mixtures with natural and synthetic fibers; in the 1970's the rate of increase was somewhat lower as a result of great pressure to eliminate harmful emissions and improve the environment. Recently, cellulose fibers have been experiencing a certain resurgence, new second- and third-generation modifications have appeared, and some producers have begun to expand and modernize their production facilities.

The trend of synthetic fiber production is shown in Table 3.

Table 3. Worldwide Output of Main Types of Synthetic Fibers (thousands of tons)

	1940	1950	1960	1970	1980
All synthetic fibers	5	69	703	4,700	10,591
polyamide	5	56	408	1,905	3,071
polyester	-	-	122	1,645	5,083
polyacrylonitrile	-	3	109	1,003	2,012
other synthetics	-	10	64	147	425

Source: TEXTILE ORGANON, Enka AG

The category of "other synthetics" includes PVC [polyvinyl chloride], PVA [poly-vinyl alcohol], polyurethane fibers and other less frequently used varieties. This survey does not include polyolefin fibers (polypropylene, polyethylene and fibers produced from sheet and strip) because statistical accounting on these began only in the 1970's and data for 1980 were not available at the time of writing.

It is clear from Table 3 that the production of synthetic fibers began to pick up speed in the late 1950's. Initially PAD fiber had no competitors, but the situation gradually began to change as the possibilities for use of polyester and polyacrylonitrile fibers increased. In 1972 world output of polyester fibers first surpassed that of polyamide fibers; this trend has continued. The increasing popularity of polyester fibers (with excellent physical and mechanical characteristics, a wide range of applications, extensive possibilities for modifying their properties and the like) was not significantly harmed even by the oil crisis of the mid-1970's. Currently polyesters account for fully 48 percent of worldwide output of synthetics (polyamides account for 29 percent, polyacrylonitriles for 19 percent and the others for 4 percent), and they have good prospects for the future: by the year 2000 the output of polyester fiber is expected to approach that of the most widely-used textile fiber, cotton.

The situation in the production of chemical fibers is further described by Tables 4 and 5, which show trends in the relative proportions of filament and staple fibers.

Table 4. Relative Proportion of Filament and Staple Fibers (percent)

	1920	1940	1950	1960	1970	1980
All chemical fibers	100	100	100	100	100	100
staple	-	52	45	53	54	56
filament	100	48	55	47	46	44

Source: TEXTILE ORGANON, Enka AG

Table 5. Relative Proportions of Filament and Staple Fibers Among Various Chemical Types (percent, for 1979)

	Filament	Staple	Total
Cellulose fiber	35	65	100
All synthetic fibers	46	54	100
polyamide	80	20	100
polyester	43	57	100
polyacrylonitrile	2	98	100

Source: TEXTILE ORGANON

It can be seen from Table 4 that the relative proportions of filament and staple fibers have gradually shifted in favor of the latter. Among individual types of synthetic fibers, however, the relative proportions differ rather considerably. While textile, technical and cord filament and cable predominate in the case of polyamides, the situation is just the opposite in the case of polyester and acrylics, where staples, cables and the like predominate.

A glance at the worldwide statistics (more detailed data are available from 1979 on) indicates that the United States has no competitor as the largest producer of chemical fibers, with an output of 3.905 million tons. It is followed by Japan (1.760 million tons) and the Soviet Union (1.111 million tons), then by Taiwan (591,000 tons), the United Kingdom (579,000 tons) and South Korea (501,000 tons). Of the other socialist countries, East Germany has 11th place, Poland 15th place, Romania 16th place and Czechoslovakia 19th place worldwide. At first glance the high ranking of the two Asian countries may appear surprising. The reason for it is that the chemical industries, and particularly the synthetic fiber industries, developed extremely rapidly in Taiwan and South Korea during the 1970's with considerable capital participation of Japanese, West German, American and other companies, based on the most modern processes, and at present these two countries not only have captured most Asian markets, but are also providing uncomfortable competition on Western European markets with their fibers and finished textiles.

As for cellulose fiber, the largest producers are the Soviet Union (635,000 tons), followed by Japan (374,000 tons), and in third place the United States (278,000 tons), where output has been declining for several years. The CEMA countries produce about a third of all of the world's cellulose fiber output, and other than the Soviet Union, East Germany and (recently) Romania occupy important positions. Czechoslovakia is in 14th place worldwide. In the case of synthetic fibers, the United States is securely in first place (3.484 million tons), followed by Japan (1.363 million tons), West Germany (760,000 tons), Taiwan (521,000 tons), South Korea (477,000 tons) and the Soviet Union (476,000 tons). Among the socialist countries, the largest producers of synthetics other than the Soviet Union are Poland (153,000 tons), Romania (140,000 tons) and East Germany (133,000 tons); in 1979, Czechoslovakia was in eighth place.

Production of Chemical Fibers in Czechoslovakia

Czechoslovakia began to produce chemical fibers only after the republic was founded. In 1919 a small viscose textile filament plant in Moravske Chrastove with a capacity of 250 tons per year began operation. In 1920 two other small plants began operation in Theresiental (now Rudnik near Hostinny) and Senice nad Myjavou, while in 1921 a factory began operation in Lovosice; this was expanded in 1935. In 1936 another viscose textile filament factory was opened in Batizovice (now Svit); its production capacity was increased in 1953, and facilities for coloring fiber material were added. The first viscose staple was produced in 1942 in the Vistra plant in Bratislava, while staple production in Bohemia was begun by Spolana Neratovice in 1947; an additional small staple production unit was also installed in Svit. In the early 1950's a rayon textile and cord filament plant began operations in Bratislava; it was one of the most modern of its time in Central Europe. In 1953-1956, the units in Rudnik and Lovosice were reconstructed to produce viscose cord filament. This ended the development of viscose fiber production in Czechoslovakia, for in the late 1960's and the 1970's, as a result of the rapid development of synthetic fibers and in the interest of improving the environment, the viscose staple plant in the Chemosvit Svit National Enterprise was shut down (1967), as were those in Rudnik (1971) and in the CHZJD [expansion unknown] National Enterprise in Bratislava (1978), as well as the textile filament in the Chemosvit National Enterprise (1978). Viscose fiber is currently produced in Neratovice (staple), Lovosice (cord filament), and Senice and Bratislava (textile filament).

The history of our synthetic fiber production began during the occupation, when the research institute of the Bata Plants in Zlin (now the Research Institute of Rubber and Plastics Technology, Gottwaldov) developed and produced the first polyamide fiber on the basis of a specially-designed process, without foreign licenses. In July 1947 a pilot unit with a capacity of 0.6 tons per week was started up, and at the end of 1949 this facility was transferred to the new Silon chemical combine in Plana nad Luznici na Taborsku. There the first 52 tons of Silon polyamide textile filament was also produced in 1952 (the trade name was invented by the writer T. Svatopluk), and Czechoslovakia thus became the seventh producer of synthetic fibers in the world. The leading position in the production of polyamides was taken over in the 1960's by Chemlon Humenne National Enterprise, which began production in a facility for manufacturing polyamide textile filament (using Soviet documentation), a facility for polyamide cord filament (from the Zimmer Company, West Germany), and other units for polyamide textile filament (ACO Company, Holland) and high-strength polyamide cord filament (Teijin, Japan); in 1969 it reconstructed the polyamide cord filament unit to manufacture polyamide cable. Now Chemlon Humenne produces more than 90 percent of all Czechoslovakia's polyamide fiber output. The obsolete polyamide textile and technical filament facilities at Silon Plana were dismantled in 1980 after more than 30 years' operation.

Silon Plana nad Luznici was also a pioneer in the production of polyesters; in 1959 it produced its first tons of polyester staple on license from ICI (England). In 1966 this enterprise started up what was then a unique production facility for polyester staple with continual polycondensation and spinning, obtained from Zimmer in West Germany. The Slovensky Hodvab National Enterprise in Senice began the production of textile polyester filament in 1969, and in 1978 it expanded its capacity to include additional facilities for polyester textile filament and granulated polyester; two-thirds of the latter is delivered to the Chemlon National Enterprise, which also began the production of polyester textile filament in 1978.

We are one of the leading countries in the production of polypropylene. A pilot polypropylene staple line began operation in as early as 1965 in the Chemosvit National Enterprise, a larger facility began operation in 1970 at CHZJD Bratislava, and a large-capacity facility was also put into operation there in 1979. In addition, CHZJD Bratislava installed a pilot polypropylene cable line in 1972 which was used primarily to produce carpets and household textiles; a larger facility went into operation there in 1975, and an additional large-capacity operation, most of whose output is intended for export to the CEMA countries, is now being completed. In 1974 Chemosvit began the production of polyester textile filament on a semicommercial scale, and in 1980 this facility was replaced by a unit with a capacity of 4,000 tons a year, the largest of its type in the world.

Other well-known types of synthetic fibers (acrylic fibers, polyvinyl chloride staples, polyurethane filament, polyvinyl alcohol fiber and the like) are not produced in Czechoslovakia. The main reasons for this intentional production structure is that at the recommendation of CEMA's operating bodies we specialize in the production of polypropylene fibers, an area in which we have rich research and production experience and sufficient starting materials, i.e. granular fiber-grade polypropylene, and have developed and tested numerous applications. In contrast, the development of polyacrylonitrile production was not provided for in the guidelines for the Czechoslovak chemical industry primarily because Czechoslovakia has available neither a materials base nor the production technology and equipment and has done little work in the field, with the exception of applications work. Nor is there any plan to begin production of polyvinyl chloride, polyurethane, polyvinyl alcohol or other less known types of synthetics here, especially since Czechoslovakia consumes only miniscule quantities of these products. The same is true of the special types of synthetic fibers with "upgraded use characteristics," e.g. aramid fiber, PAD-4 and the like.

Table 6 surveys the production of chemical fibers in Czechoslovakia.

Table 6. Production of Chemical Fibers in Czechoslovakia, 1920-1980 (thousand tons)

	1920	1940	1950	1960	1970	1980
All chemical fibers	0.3	5.4	27.0	61.9	100.8	163.5
cellulose	0.3	5.4	26.9	58.9	69.3	54.9
synthetic	-	-	0.1	3.0	31.5	108.6

It is clear from Table 6 that cellulose fiber production developed especially rapidly in 1950-1960, when output more than doubled, while production subsequently leveled off and after 1979 showed a considerable drop of more than 20 percent because of the shutting down of an ecologically undesirable viscose staple production facility in Bratislava, and subsequently of a smaller unit producing textile filament at Svit. Synthetic fibers have shown dynamic growth in the last two decades. In 1960-1970 output increased 10.5 times, while in 1970-1980 it was up almost 3.5 times. The development of synthetic fiber production structure in the last few years is interesting (Table 7).

Table 7. Share of Individual Fiber Types in Overall Output of Synthetics (percent)

	1950	1960	1970	1980
All synthetic fibers	100	100	100	100
polyamide	100	88	68	45
polyester	-	12	29	33
polypropylene	-	-	3	22

Table 7 shows that the share of polyamide fibers has gradually fallen as the output of polyester and polypropylene fibers has risen. Polypropylene fibers have an important place in the production structure (accounting for more than a fifth of output, as a result of production specialization within CEMA), at a level considerably higher than the world average.

In addition, in 1980 Czechoslovakia produced 15,000 tons of polyolefin fibers from polymer strip and sheet (the usual starting materials are polypropylene and high-pressure polyethylene granules), which have been a fully adequate replacement for linen, jute and sisal in the production of sacks, tarpaulins, packaging materials filter textiles and the like. The primary producer of these fibers, worldwide output of which (including textile varieties) has exceeded a million tons, is the VHJ Lanarsky prumysl Trutnov.

The attention which has been devoted to the production of synthetic fibers in Czechoslovakia in recent decades is indicated by the fact that in the last two five-year plans, Kcs 6 billion has been invested in this sector. We now produce about 1,000 varieties of chemical fibers in various final forms, more than 600 workplaces and organizations, primarily in the textile and rubber industries, as well as production associations, locally operated enterprises and consumers in the Ministry of Agriculture and Foodstuffs, the Ministry of General Engineering, and the Ministry of Electrical Engineering. The share of synthetic fibers is increasing most rapidly in the textile industry. While in 1960 it was only 2 percent, in 1970 it had increased to 14 percent, in 1975 to 23 percent, and in 1980 to at least 32 percent. In the knitting and woolens industries the amount of synthetics used has already exceeded 50 percent, while they will continue to have a relatively small share in the cotton industry, amounting to only 10 percent in 1980.

Prospects for Future Development of Chemical Fibers Worldwide

The future development of chemical fibers worldwide is very closely associated with the economics of the various countries and is governed by a number of factors including the raw materials situation, the level of technology in production, finishing and other processing, and the differing requirements of the public as regards clothing, household and technical textiles. Even recently, forecasts of output and use of chemical fibers differed little from the levels actually attained, and in a number of cases predictions were even exceeded as a result of the very rapid growth of this sector. But the most important turning point came in the mid-1970's, when as a result of the oil crisis and economic difficulties in a number of capitalist countries, the long-term forecasts of development in chemical fibers suddenly became unusable, for the undesirable consequences of these circumstances had a pronounced effect on this industry and considerably changed views about future development. Nor were those who developed forecasts of development of fiber production in 1981 much wiser. Although in 1976-1979 production picked up somewhat, 1980 again brought some elements of crisis, such as limitations on production resulting from nonuse or elimination of production capacities, important problems in the capitalist textile industry and so on (although these problems did not affect the socialist countries and some Third World countries in Asia and South America); as a result worldwide output of chemical fibers again dropped below the 1979 level. Nor are western experts optimistic in their estimates of development in the near future. A particular basis for this attitude is the expected further cutting back of production capacities in Western Europe, with the primary purpose of decreasing the high costs to producing companies. Experts estimate that by 1985 the demand for synthetic fibers in Western Europe will have to adjust to output levels which have decreased to 500,000-600,000 tons below the current level. Only in this way would it be possible to utilize about 90 percent of available production capacity, which would assure the required profitability. Producers of chemical fibers in the United States and Japan face similar difficulties.

Because of this complicated situation, it is difficult to forecast development of chemical fiber production in the longer term. Nonetheless, our consideration of the further development of this progressive branch of chemistry must be based on some suitable forecasts. The following are the main requirements.

1. In spite of the continuing interest in conventional natural materials (cotton and wool) and cellulose fiber, we may expect that synthetic fibers will be the fastest-growing textile materials in the near future and that polyester filament and staple will continue to hold the lead in this sector, since they offer the widest range of applications.

2. We may assume that before the end of the century no other type of textile fiber whose mass production could exceed that of the currently used types of textile materials will appear.

3. In all probability no chemical fiber with universal properties will be developed and put into production before the end of the century, because fiber processors require characteristics which are not mutually compatible. We may expect significant further progress in the development of processes and equipment for fiber production, much more efficient use of basic and auxiliary raw materials, better energy conservation in manufacturing processes, more extensive use of automation, continuous processes, data processing and the like, a considerable increase in labor productivity and the introduction of new, advanced methods of processing chemical and particularly synthetic fibers. Research and development in the chemical fibers field will concentrate primarily on special types and on modifications with desirable use characteristics, while attempting to achieve suitable combinations of more desirable properties at an acceptable price.

4. The fiber production and textile industries will devote much more attention to the solution of ecological problems, particularly the elimination or recycling of gaseous, liquid and solid wastes. According to estimates of future fiber production, we may expect that in the year 2000 some 7 to 10 million tons of waste will be produced annually. About 5 to 10 percent of this total will consist of wastes from the production of fibers, about 40 to 45 percent will be waste from the textile and clothing industry, and the remainder will consist of used textiles. But there still exists no economically feasible process for separation or utilization of mixed fiber (about 30 percent of the total amount of waste). The successful solution of this important problem not only would help to improve the environment, but also would make possible effective utilization of this hitherto neglected source of valuable raw materials.

Now let us make some observations on the prospects for production of the main types of textile fibers. Experts disagree on the share of total textile fiber output which will be occupied by the main types of natural fibers. There is full agreement that an increase in the output of wool and natural silk is unlikely, especially since silk requires 4 times more land area to produce it than does cotton, while wool actually requires 1,000 times more area, even though in this case it is land unsuited for crop production. But forecasts differ regarding cotton, which is currently the most widely used type of textile fiber. One school of thought holds that the land area devoted to it will decrease steadily but cotton yields per unit area will increase, so that by the year 2000 output will be at least what it is now, and more probably will be higher. However, there is also a completely opposite viewpoint. For example, representatives of the American Enka Company forecast that by the year 2004 most cultivated land will be used for growing food, and cotton production will decrease to a minimum. One of the main arguments for this viewpoint is that from the beginning of its growth period to the end of the life of a clothing product, cotton uses up more energy than fibers such as polyester. Our view is that cotton output is likely to be maintained at approximately the current level, or to decrease slightly, with the difference being made up by synthetics, and that the use of cotton-synthetic mixtures will increase only slightly, while use of mixtures of cotton and viscose or acetate will decrease considerably.

Estimates of the future output of cellulose fibers (viscose and acetate) show the widest divergence. While most West European and Japanese producers agree in predicting stagnation or slow growth of output through the year 2000, some American companies, particularly Chemtex and ITT Rayonier, make forecasts of cellulose fiber output which may be excessively optimistic: they consider that by the end of the 20th century output of cellulose fibers will rise to 8-14 million tons, i.e. 2.5-4 times the current level. They support their forecast by the assertion that the polymer starting material, i.e. industrial cellulose, is continually renewed in nature, in contrast to oil, and is not subject to the same limitations on growing area as cotton. In addition, they assume that the problem of emissions and wastewater will be solved and that there will be a number of innovations in the product selection, including extensive use of next-generation fibers. One is more inclined to the soberer views of organizations such as Lenzing (Austria), Bayer (West Germany) and Teijin (Japan), which quite justifiably call attention to the fact that the machinery and process equipment used for this oldest type of chemical fiber do not meet future demands, and that radical modernization would require considerable investment expenditure, both for emission control and waste water purification and for improvement of the production process itself, including making it continuous, automating it and concentrating production. Accordingly they expect only a modest increase in output and consumption of cellulose fibers, to about 4-4.5 million tons, in the year 2000.

In the past 20 years the world output of synthetic fibers has increased 15-fold. But the last 5 to 7 years, a period begun by the oil crisis, have revealed certain problems in this sector. The most important of these is limited capabilities for delivery of the basic starting materials for synthetics production, starting with oil, and the closely associated, increasing pressure to save energy, along with difficulties in providing machinery for fiber production and processing, the necessity of producing auxiliary substances (primarily dyes, brighteners, preparations and oils) for synthetics, license barriers and other factors. On the other hand a number of factors clearly support a further increase in the output of synthetics. They include, for example, the increasing world population, increasing per-capita fiber consumption, the limited increase in output of natural and cellulose textile fibers, progress in fiber production and treatment technologies and in applications, great potential for conservation, improved labor productivity and the like. Between 1960 and 1980 the share of synthetics in total textile fiber consumption rose from 5 percent to 39 percent. This share will continue to increase, even if somewhat more slowly than previously.

For illustration we present several forecasts of the future growth of production of different types of textile fibers through the year 2000.

Table 8. Forecasts of Output of Textile Fiber Through the Year 2000 (millions of tons)

	1980	2000: 1	2	3	4	5
All natural fibers	14.5	13.0	12.0	13.0	15.5	14.5
Cellulose fibers	3.6	4.0	8.0	3.0	4.0	4.5
Synthetic fibers	10.6	35.0	30.0	35.0	25-30	25.0
All textile fibers	28.7	52.0	50.0	51.0	44.5-49.5	44.0

Natural fibers include cotton, wool and natural silk.

Key: 1. UN forecast, March 1977. 2. Forecast by Chemtex Company, USA, February 1981. 3. Forecast from "Lexicon of Chemical Fibers" (West Germany), 1979. 4. Forecast of West German experts, 1978. 5. Author's forecast.

This survey makes it clear that the forecasts differ most with regard to chemical fibers and sometimes contradict one another as a result of the forecaster's profession and company affiliation. If we assume that in 2000 the world population will be 5.5-6 billion, the annual increase in production and consumption of textile fibers would have to range from 0.7 to 1.2 million tons, close to the figures for the boom years of the 1960's and early 1970's. These forecasts involve primarily an increase in chemical fibers, since, with the exception of No 4, they forecast a stagnation or decrease in the output of natural fibers.

Prospects for Production in Czechoslovakia

No complete conception of the prospects for development of chemical fibers in Czechoslovakia through the year 2000 has yet been worked out in detail and in all its implications. There exist only some limited studies, which do not deal comprehensively enough with this problem. Although they are based on conceptions of future consumption of textile fibers by the processing sectors (textile and rubber industries, and other consumers) and on population curves, they do not take sufficient account of the factors which are critical to the further development of chemical fibers in Czechoslovakia (raw materials, including oil, energy, investment and foreign exchange capabilities, technical progress and the like).

The most specific conceptions of the prospects for chemical fibers in Czechoslovakia are those for the Seventh Five-Year Plan. No such pronounced growth as took place in the preceding two five-year plans is planned for 1981-1985. We can expect the greatest growth in polypropylene fibers as a result of the gradual coming on stream of new large-capacity polypropylene textile filament, cable and staple facilities. There will be only a small increase in the output of the other types of synthetic fibers, resulting primarily from intensification measures (polyester staple, polyamide cable).

During the Seventh Five-Year Plan the output of cellulose fibers will stay level, or may even decrease temporarily toward the end of the period as a result of necessary reconstruction of the viscose staple production facility in the Spolana Neratovice Kraj Enterprise.

Accordingly, the chemical fiber producers must devote more attention to improving quality and to innovation in product selection than previously. This task is even more important in view of the fact that we import a considerable quantity of chemical fibers (the figure will be nearly a third of total consumption in 1985), and since most of the imported selection, especially synthetic fibers, is extremely demanding in terms of foreign exchange. The central economic organs have long been intensively studying the problems of quality and provision of the needed selection, and analyses have indicated that there are realistic ways of improving the present state of affairs. The most important of these is the pursuit of anti-import programs with extremely rapid payback, financed by recoverable foreign exchange credits. The main aim of such measures is to make available to domestic producers certain scarce types of fibers, particularly those which we import under unfavorable price conditions for convertible currency (continuous synthetic filament, formed fiber, polyamide cable, modifications, special varieties and the like). Preparations are now being made to implement several suggestions involving recoverable foreign exchange, and others are being developed. During the Seventh Five-Year Plan the main commodity for export to the socialist countries remains polypropylene fiber, which we will exchange with these countries for scarce textile raw materials (cotton, viscose staple, acrylic fiber and the like) or important chemical products.

In 1986-1990 our attention is likely to be concentrated primarily on expanding the output of selected types of polyester fibers (technical filament and staple), which will become scarcer in the 1980's. Reconstruction of the Spolana Neratovice Kraj Enterprise is expected to be completed. The increase in output of polyamide fibers is likely to be minimal, and the increase in polypropylene fibers is likely to involve primarily cable for domestic textiles and export to the socialist countries and polypropylene textile filament, in which areas it will be necessary to expand the output of smooth-surface and coarse-denier fiber for the wool industry (domestic textiles and carpets). An increase in the output of polypropylene staple will depend to a considerable degree on successful development and production of cotton-like products which would at least partially replace cotton and other scarce fibers.

The development prospects for chemical fibers in Czechoslovakia after 1990 will be highly dependent on the long-term conception of our light industry, i.e. whether it will continue to be an important export sector to both socialist and nonsocialist countries, or whether it will concentrate primarily on meeting domestic needs. In this period the problems of cellulose fibers, both textile filament and viscose staple and cord, will require solution (obsolete machinery, emissions, poor quality, limited selection and the like). Among the other types of fibers, as in the Eighth Five-Year Plan the primary attention will be devoted to expansion of polyester and polypropylene production, and the importance of synthetic fibers for a wide range of technical applications will increase.

In general terms, we may state that development of chemical fiber output in Czechoslovakia during the near future will aim at the following basic goals:

--improving the use characteristics and quality of fibers;

--expanding the selection of modifications, special fibers and advanced-generation fibers for clothing, domestic and technical purposes;

--decreasing consumption of raw materials, auxiliary materials and energy;

--increasing the labor productivity of production units, introduction of continuous processes, automation, extensive use of data processing equipment and the like;

--the search for suitable replacements for imported fibers, particularly natural fibers.

Research and development in the chemical fibers field in Czechoslovakia will continue to be performed primarily by our own manpower and in cooperation with other CEMA countries. Deliveries of some raw materials (caprolactam, dimethyl terephthalate) and auxiliary materials (dyes and preparations) will remain a bottleneck during the 1980's, as will the provision of machinery and equipment for new fiber production facilities; as previously, we will depend primarily on West Germany for imports.

Conclusions

Chemical fibers will continue to hold the decisive position among starting materials for the textile, rubber and other industrial sectors in coming years. In particular, the importance of synthetic fibers will continue to grow; in the period through the year 2000 they will account for most of the growth in output of fiber materials. Although natural and cellulose fibers will continue to hold the attention of producers and processors, their share of total textile materials will decrease steadily. The efforts of research, development, production, processing and application of chemical fibers will focus primarily on:

--increasing efficiency and labor productivity in the mass production of cellulose and synthetic fibers;

--development and further expansion of the number of modifications and special fiber types in accordance with purchaser requirements;

--introduction of increasingly modern and effective processing technologies;

--the development of new, nonconventional designs for the production of textile surface configurations;

--comprehensive utilization, and the further solution of ecological problems in the production, processing and use of chemical fibers, including effective utilization of fiber production and textile waste.

Meanwhile, the importance of socialist economic integration in the fiber field, coordination of investment programs in fiber production, and exchange of fiber types will continue to grow in the socialist camp.

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